or less separated by a connective-tissue stroma containing blood-vessels.

(*b*) *Alveolar Sarcoma.* This group of tumors must be regarded with suspicion. Some included in it may have been slightly pigmented melanomata; others were unquestionably carcinomata. Possibly rapidly growing tumors, arising from striated muscle cells, possess an alveolar arrangement and may have been included under this heading.

D. Tumors Arising from Endothelial Cells.—(*a*) *Hæmangioma, Hæmangio-endothelioma.* The congenital vascular nævi of the skin and the cavernomata of the liver are abnormalities, not true tumors, but they may give rise to autonomous vascular tumors. A hæmangioma is a slow-growing tumor composed of blood-vessels, which exhibits the characteristics of true tumors. The vessels often dilate and become cavernous in type. Rarely the tumors are multiple. The term hæmangio-endothelioma is applied to rapidly growing tumors arising from the endothelium of blood-vessels. As the lumina of the new-formed capillaries often become occluded by intravascular proliferation or by rupture of continuity, rows of anastomosing cells and concentric cell masses are usually formed in parts, at least, of the tumors. There is a gradual growth of connective tissue between the cells separating them from each other.

(*b*) *Lymphangioma, Lymphangio-endothelioma.* These names are applied to the slowly and rapidly growing tumors arising from the endothelium of lymph vessels.

(*c*) *Dural Endothelioma.* Tumors distinguished by this title arise from the endothelium lining the arachnoid space. They vary in rate of growth from slow to rapid. The structure of the tumors varies greatly; it may be cellular like a sarcoma or more or less fibrous like a cellular fibroma. The cells may have an alveolar arrangement with the cells often grouped in whorls, or the cells may be more or less uniformly distributed in the stroma.

E. Tumors Arising from Nerve Cells.—(*a*) *Neuroma.* This term is often applied to a tumor-like mass which follows amputation of a limb, and is due to an attempt at regeneration made by the axis cylinders of a cut nerve. As an axis cylinder is only a process of a cell it cannot give rise to a true tumor. A true neuroma is a tumor composed, in large part at least, of ganglion cells which may produce medullated or non-medullated nerve fibres. Neuromata are rare, and arise chiefly from the sympathetic nervous system.

2. Epithelial Tumors.

In this group of tumors epithelial cells play as a rule the more important part. Like the cells in the tumors already described they cannot exist by themselves, but are always accompanied by a certain amount of connective tissue and blood-vessels on which they depend for support and nutrition. In some of the tumors the stroma is slight in amount; in others it is abundant, rapidly growing, and suggests active inflammatory tissue; in still others the connective tissue accompanying the epithelium is very abundant, and cannot be regarded as stroma but as part of the tumor formation.

A. From surfaces covered with epithelium tumors arise which are divided into two groups, according as they are elevated above the lining epithelium or invade the tissues below it.

(*a*) *Papillary fibroma,* a tumor composed of papillary outgrowths of connective tissue and blood-vessels, covered externally with a single layer of epithelium, or with a pavement epithelium. Sometimes the connective tissue is very slight in amount, sometimes very abundant.

(*b*) *Carcinoma,* a tumor composed of branching and anastomosing columns and masses of epithelial cells which invade the tissue beneath the lining epithelium, from which the tumor arises and which give rise to metastases.

B. From the epithelium lining glands, two general types of tumors arise.

(*a*) *Adenoma,* a tumor composed of new-formed glands which do not invade the surrounding tissue. Closely related to the adenoma are on the one hand the *adenocystoma,* an adenoma in which some of the glands dilate to form cysts, and the *papillary adenocystoma,* an adenocystoma with papillary projections from the wall. This latter tumor sometimes approaches the carcinoma in malignancy, and is even classed by Ribbert as one form of it. On the other hand, the connective tissue surrounding the glands may play an equal or even more important part than the epithelium, and then we get the *adenofibroma,* or, if papillary ingrowths occur, the *intracanalicular papillary adenofibroma.*

(*b*) *Malignant adenoma, adenocarcinoma, carcinoma.* A closely related group of tumors, morphologically somewhat different, biologically alike, which are often included under the term carcinoma. They also correspond biologically with the carcinoma of the first group of epithelial tumors.

The term carcinoma is unfortunately employed in two ways—biologically as a designation for all malignant epithelial tumors, and morphologically to distinguish in malignant epithelial new growths the epithelium growing in solid masses from that which grows in the form of glands or cysts.

There is a certain tendency to give a special name to all epithelial tumors coming from a certain organ, such as malignant hypernephroma for epithelial tumors of adrenal origin, provided the cells or their secretions are very characteristic.

In the above classification those tumors in which epithelium and connective tissue play an essentially equal part are often separately considered under the heading fibro-epithelial tumors. This would include papillary fibromata of the skin and the adenofibromata of the breast.

It is to be noted, however, that adenomata of any organ imitate that organ not only in regard to the glands, but also in regard to the amount and character of connective tissue which is between the glands. In the liver and adrenal there is very little connective tissue and adenomata of these organs exhibit the same condition. But in the mammary gland, where there is always a great amount of dense connective tissue between the glands, the adenomata arising there have much connective tissue associated with them. It would seem as if the two tissues worked together in an attempt to form mammary-gland tissue.

C. Cysts Lined with Pavement Epithelium.—Cysts lined with a single layer of epithelium belong in one of two classes. The first are due to dilatation of pre-existing glands or cavities under the influence of retained secretions. The second are true tumor formations and begin as adenomata, of which some of the glands dilate and fuse to form cysts.

There is another class of cysts which are lined with epidermis. Those due to the dilatation of the ducts of sebaceous glands (wen, atheroma) are certainly not tumors. There is another group, however, which is usually included among the new growths. These are the simple dermoids occurring chiefly along the lines of closure of the embryonic fissures and the cholesteatomata which are found almost exclusively in connection with the central nervous system. They are probably both to be regarded not as true tumors, but as embryonic inclusions and displacements. The dermoid cysts enlarge as sebaceous cysts do under the influence of retained secretions. If the secretions could escape they would not enlarge any more than do the fistulæ originating from branchial clefts.

The cholesteatoma is due to the inclusion within the central nervous system of ectodermal cells, which would normally form epidermis. The apparent tumor is due to the gradual accumulation of dead desquamated epidermal cells.

The simple dermoids and the cholesteatoma belong in the same class with aberrant adrenal rests. They are unquestionably under the physiological control of the body. They can give rise to tumors, but are not themselves true tumors. They have been classed with the tumors largely because under the influence of retained secretions they often attain a considerable size.

3. Mixed Tumors.

There are three principal groups of mixed tumors which require attention. It is possible, however, that the fibro-epithelial tumors should be added to them as the simplest type of mixed tumors.

A. Mixed Tumors of the Salivary Glands.—They develop most commonly in or near the parotid. They are nodular tumors of varying size which are usually benign, but may become malignant. They are composed of tissue elements derived in part from the ectoderm, in part from the mesoderm. The latter germ layer may give rise not only to connective tissue, but often to cartilage and more rarely to bone, fat, and lymphoid tissues, and even to striated muscle cells. The epithelium of ectodermal origin may occur in the form of glands or in solid masses as in a carcinoma.

These tumors probably arise from embryonic displacements of cells of the ectoderm and mesoderm during the formation of the branchial arches and of the parotid and submaxillary glands.

B. Mixed Tumors of the Genito-Urinary Tract.—They occur most commonly in the kidney, but arise sometimes in the uterus and vagina, and even in the wall of the bladder. They are congenital tumors which are always malignant, and may give rise to metastases. They are composed of rapidly growing connective tissue which resembles sarcomatous tissue, of embryonic striated muscle cells, of tubular structures lined with epithelium, and occasionally of fat tissue and cartilage. These tumors unquestionably arise from the displacement, at an early stage of embryonic development, of undifferentiated cells, which under normal conditions are capable of giving rise to differentiated cells such as occur in the tumors.

C. Teratoma.—This group of tumors can be divided into two subdivisions.

(*a*) *Embryoma.* In the ovary and to a less extent in the testicle tumors occur which vary from a simple to a very complex structure. They may contain practically all the different tissues present in the body, *i.e.*, all three embryonic germ layers are represented. It is probable that these tumors arise from undifferentiated cells which under normal conditions are capable of giving rise to embryos, *i.e.*, from ova or more probably from cells which give rise to ova.

(*b*) *Fœtus in Fœtu.* Very complicated tumors, more or less similar in structure to those occurring in the ovary and testicle, sometimes occur in other parts of the body. They are probably due to the inclusion in a fœtus of an ovum or of cells developed from an ovum, which under normal conditions would give rise to another fœtus.

Origin of Tumors.—A certain number of tumors unquestionably arise from cells which during embryonic development are displaced from the site where they belong. Some of these cells are displaced at an early stage of cell differentiation, and hence are capable of producing tumors of a complex nature, containing a variety of tissues, as for example the mixed tumors of the kidney. Other cells are displaced at a later period of development when they are more or less completely differentiated, and in consequence they give rise to tumors consisting essentially of a single kind of cell, as for example the tumors of adrenal origin.

Of these displacements of embryonic cells the commonest and most easily recognized are the aberrant adrenals or hypernephromata. Their size probably corresponds to the amount of gland tissue which they would have produced if they had remained in their proper situation. Small, misplaced spleens are not at all uncommon. Displaced bits of pancreatic tissue are less frequent. The so-called cholesteatomata found in connection with the central nervous system, the remains of branchial clefts and of the lower end of the neural canal, and the gland-like structures so common in the wall of the oviduct are all examples of cells or groups of cells displaced during embryonic development. Pigmented and vascular nævi are still other examples which should, however, probably be classed as abnormalities rather than as displacements. Some of these "fœtal rests" become so large in consequence of the accumulation of retained secretions (the cholesteatoma and the simple dermoid) that they are usually classed as tumors.

It is probable that all of these displaced tissues are under the normal physiological control of the body. They can give rise to tumors, but are not themselves new growths.

Certain displacements of embryonic tissue are recognized only by the tumors to which they give rise, as for example those from which come the mixed tumors of the genito-urinary tract and of the salivary glands.

The adenofibromata of the breast may be derived from displacements in post-embryonic life, at the time when the mammary gland is developing. They certainly suggest an attempt at the formation of mammary-gland tissue.

The important point to bear in mind in regard to these tumors which unquestionably arise from embryonic displacements of tissue, such as the malignant hypernephromata, and the mixed tumors of the urogenital tract, is this, that they are as malignant as any tumors which exist, and that they give rise to metastases.

Etiology of Tumors.—In regard to the cause of tumors we know absolutely nothing. Bacteria, protozoa, and blastomycetes have been claimed to be the active agents in the production of some of them, particularly of carcinoma. It must be acknowledged that blastomycetes produce a curious form of tissue proliferation containing great numbers of endothelial cells, which to an unskilled observer might suggest an epithelial growth, but the result is granulation tissue, not a true tumor. It has been claimed that trauma (acute injury and chronic irritation) may so stimulate the cells of a part that a tumor formation is the result, but it is impossible to regard this as a general cause, although in certain cases it is possible that it is the exciting cause.

We thus come back to displaced cells as a possible solution of the question. In many cases, certainly, tumors arise from them, but the reason for it we are unable to understand, because most of these tissue displacements persist throughout life without leading to anything abnormal. Possibly a series of experiments with displaced tissues of various sorts might throw some light on the subject. Certainly at present such experimentation is the most promising field for investigation.

F. B. Mallory.

TUNNELLING, DANGERS OF.—The scope of this article is to deal with such explosives as are generally used in public or private works of improvement, the effects of the explosion upon the workingmen employed, and the way in which accidents with such explosives frequently occur.

I. Explosives Used in Blasting.—There are numerous kinds of explosives: Gunpowder, guncotton, nitroglycerin, dynamites, picrates, fulminates, etc. It is not the purpose of this article to deal with all of the different kinds of explosives, but simply with those which come into common use.

The principal ingredients of the various explosives are potassium nitrate, sodium nitrate, ammonium nitrate, potassium chlorate, nitric acid, sulphuric acid, sulphur, the hydrocarbons, benzene, toluene, naphthalin, carbohydrates, cellulose, alcohols, glycerin, ethers, acetone, camphor, vaseline, paraffin, kieselguhr, randanite, tripoli, coal dust, and the alkaline carbonates.

Gunpowder is of two kinds—nitrate and chlorate. Ordinary black gunpowder belongs to the *nitrate* class, and is composed of potassium nitrate, 75 parts; charcoal, 15 parts; sulphur, 10 parts. There are many special powders of this class which vary, not so much in their composition as in their shape, size of the grain, density, and hardness, such as hexagonal, perforated, prismatic, etc. Other powders vary only as to the nitrate used, whether barium nitrate, strontium nitrate, or sodium nitrate.

The results of the explosion of these powders vary. The greater part of the product is represented by sulphate of potash, carbonic acid, and nitrogen, but there is also to be found potassium carbonate, sulphide, hyposulphate, and sulphocyanate, ammonium carbonate, carbon monoxide, carbon dioxide, hydrogen, hydrogen sulphide, and marsh gas.

There are quite a number of *chlorate* mixtures or powders, most of which—as Harvey's, Davey's, Hill's, etc.,—are used for fuse composition; but, as they are attended with great danger in handling, they are of no great practical value.

The picrates are made with a basis of picric acid, or trinitro-phenol. These powders are used almost exclusively in France.

Borlinetto's powder is composed of potassium picrate and potassium nitrate with charcoal.

Brugère's powder is composed of ammonium picrate with potassium nitrate.

Melinite is composed of a mixture of fused picric acid and trinitrocellulose dissolved in a mixture of ether and alcohol; in other words, guncotton dissolved in ether, to which is added picric acid.

Lydite, the English explosive, is identical with melinite. If fully exploded, these powders deflagrate into nitrogen, carbonic oxide, or carbonic acid, hydrogen, carbonate of potash, etc.; therefore the gases produced by them are not very injurious in character.

Other explosives of the nitro-substitution class are mono-, di-, and trinitro-benzene. *Bellite* and *Securite* (both composed of ammonium nitrate with meta-dinitrobenzene) are very powerful and yet safe to handle. Finally, there are nitrotoluene, mono-, di-, tri-, and tetranitronaphthalin, *Volney's powders* (mixtures of nitrated naphthalin, saltpetre, and sulphur), *Favier powders*, *Emmensite* (similar to picric acid), *Gelbite*, and *Roburite*.

Roburite is composed of ammonium nitrate with chlorinated dinitrobenzol, and is a yellow-brown powder with an odor of bitter almonds. It cannot be exploded by concussion, pressure, friction, shock, or fire, but only by a powerful detonator, such as 1 gm. of the fulminate of mercury.

Nitroglycerin is the most powerful of all explosives. But on account of the danger in handling it, it is not used as much in blasting operations to-day as formerly, but is the base of other high explosives. It is composed of nitric acid, sulphuric acid, and glycerin. It is an odorless, colorless (or slightly yellow) liquid, with a sweetish taste, insoluble in water, but soluble in ether or wood alcohol (methyl alcohol). Mixed with wood alcohol it loses its explosive property, but by adding water to the mixture it separates and can again be used as an explosive. It evaporates at 212° F., and freezes at about 30° F. Some of its incompatibles are muriate of ammonia, sulphate of iron, and the sulphides generally. It is decomposed by sulphureted hydrogen and sulphur is precipitated; it is also decomposed by calcium sulphide. I mention these as they can be used as antidotes for poisoning by nitroglycerin.

Nitroglycerin explodes from pressure, or from a blow, or at 306° F. Properly to explode nitroglycerin great heat and pressure are needed. If it is exploded by means of gunpowder the explosion is not general and a part is not exploded. The method now in vogue is to use fulminating caps, and if these are of sufficient size and properly made they effect a complete detonation.

A cause insufficient to explode nitroglycerin in wood or paper will explode it in tin or other metals. Confinement or compression makes nitroglycerin and its compound explode more easily.

The result of the explosion of nitroglycerin gives water, 20 parts; carbonic acid, 58 parts; oxygen, 3.5 parts; nitrogen, 18.5 parts. And according to Nobel, 1 litre of "blasting oil" gives 10,400 litres of gases.

In point of rapidity the explosion of nitroglycerin is practically instantaneous. The characters of the products of explosion of many of the compounds are alike, but in the case of some they vary according to circumstances and condition, such as the method adopted for producing a high temperature, pressure, expansion, etc.

By mixing nitroglycerin with some porous substance it is readily absorbed, and produces an explosive comparatively safe to handle. These mixtures of nitro-compound are what is commonly known as *dynamite*.

The names of the various dynamites are Giant powder No. 1 and No. 2; Dualin, Atlas A and B, Vulcan, Judson, Rendrock, Hercules, American Safety, Carbonite, Stonite, Horsley, Dynamite de Trauzl, and Gelignite.

For the purposes of study there are practically two classes of dynamite, which might be termed inorganic and organic, according to the absorbent used. As a type of one class is that made with infusorial earth, kieselguhr, a soil found in Germany and which is composed of siliceous diatoms; and of the other, that made with ground wood pulp or sawdust. Others still are made from a combination of both kinds. The results of the explosion, however, are practically the same in either case, except that the dynamite made with an organic absorbent yields an additional amount of carbon.

As a type of the first class we have Giant powder No. 1: nitroglycerin, 75 parts; kieselguhr, 24.5 parts; sodium carbonate, 0.5 part. And as a type of the second class, we have the American safety powder: Nitroglycerin, 68.81 parts; sodium nitrate, 18.35 parts; wood pulp, 12.84 parts.

Dynamite is safe or unsafe to handle, according to the amount of oil (nitroglycerin) that is absorbed. The capacity of the absorbent varies with the temperature. Thus, a powder that is comparatively safe at 50° F. may be leaky at 100° F.

When dynamite is frozen it is more difficult to explode, and one cap will rarely make it deflagrate.

Guncotton is made by putting ordinary cotton in nitric and sulphuric acids. The cotton is first steamed with caustic potash, and then immersed in a mixture of sulphuric and nitric acids in the proportion of three to one by weight; and then it is washed until free from every trace of acid, and dried in a cool chamber.

Guncotton is harsher to the touch than ordinary cotton and is insoluble in water. It is soluble in ether, ammonia, and acetone. If a flame is applied to it, it burns with a flash, but without explosion. It is one of the safest of explosives. When properly exploded *in vacuo* the resultant gases are carbonic oxide, carbonic acid, marsh gas, olefiant gas, nitric oxide, nitrogen, hydrogen, aqueous vapor. Guncotton in itself is not used for blasting, but is sometimes mixed with other ingredients.

Tonite is composed of guncotton 52½ parts, barium nitrate 47½ parts.

Potentite is composed of guncotton 66.20, potassium nitrate 33.80.

Explosive gelatin is made by dissolving guncotton in nitroglycerin by the aid of heat, the result being a jelly-like mass. It is of a dark-yellow color. Unconfined it will burn without exploding. If confined and heated to 399° F., it explodes violently. It is more sensitive when frozen than in the unfrozen state, and can be readily detonated by the impact of a bullet. In this it differs from dynamite, which is less apt to do so.

Forcite is a gelatin dynamite largely used in the United States, and is gradually supplanting all other forms of dynamite. As this is the dynamite now most commonly used, I give its full composition:

Nitroglycerin	98 parts	Gelatin	50 parts.
Nitrocotton	2 parts		
Sodium nitrate	76 parts		
Sulphur	3 parts	Dope	50 parts.
Wood tar	20 parts		
Wood pulp	1 part		

The smokeless powders are composed principally of insoluble and soluble nitrocellulose.

Cordite, the explosive adopted by Great Britain, is

composed of nitroglycerin, guncotton, and mineral jelly (vaseline). The gases evolved by explosion are carbonic acid, carbonic oxide, nitrogen, and hydrogen. Other powders of this class are Ballistite, Maximite, Schultze powder, Wetteren Indurite, Rifleite, Leonard, etc.

Other explosives belonging to no especial class are *Rack-a-rock*, composed of potassium nitrate and mino-nitrobenzene.

Hellhoffite, composed of metadinitrobenzene and nitric acid.

Oxonite, composed of picric acid and nitric acid.

Panclastite, composed of nitrogen tetroxide and carbon disulphide.

Romite, composed of ammonium nitrate, nitronaphthalin, paraffin oil, and potassium chlorate. It explodes spontaneously.

Fulminate of mercury is used for exploders, percussion caps, and detonators. It explodes violently when compressed or struck or rubbed between hard surfaces, or when touched with concentrated sulphuric acid or any ignited body. When used in a percussion cap it is, as a rule, mixed with potassium chlorate in the proportion of 75 parts of the fulminate to 25 of potassium chlorate.

There are many fulminates, but the fulminate of mercury is the only one in general use, except for toy caps, which contain fulminate of silver.

When it is exploded the following reaction may occur:
$5\,HgC_2N_2O_2 + 4KNO_3 = 5Hg + 8\,CO_2 + 7N_2 + 2\,K_2CO_3$.

II. DANGERS ENCOUNTERED.—Asphyxia, or partial asphyxia, with a general poisoning and consequent disturbance of the system, is frequently met with in the construction of tunnels in the present day, and is due to the use of these "high explosives"; for in the removal of rock, in construction work of this nature, dynamite or nitroglycerin is used in considerable quantities.

When the blasting is done in open-cut work, as on railroads, the gases, after the explosion, immediately distribute themselves in the atmospheric air, and no effect has been noticed on the workmen employed. But when the explosions take place in tunnels, or in mining or other partially closed cavities, and the gases or residue are slow to escape from the mouths of the tunnel or up an air-shaft, serious deleterious effects are produced.

There are two classes of cases of poisoning produced by breathing the products of the explosion of such materials: First, acute cases, in which a considerable quantity of the residue is inhaled at one time; and secondly, chronic cases, or those in which a small amount is constantly breathed for a long time. The acute cases vary according to the amount inhaled.

Where the amount of dynamite used is not large, or where after the explosion a considerable quantity of fresh air has been mixed with the products of the combustion, or where the workman has, after a few breaths, become giddy and is pulled away by others and sent to the surface, the effects produced are the following: a trembling sensation, flushing of the face, succeeded sometimes by pallor, frequently nausea, sometimes vomiting, with throbbing through the temples, and fulness in the head, as if it would burst, followed by an intense headache characteristic of poisoning by nitrites—similar to that of nitrite of amyl, only not so violent, but more persistent, frequently lasting forty-eight hours. The heart's action is increased, and the pulse is full and bounding, though somewhat compressible, and varying in rate from 100 to 140. The condition is described by the workman as a "dizziness." He feels as if drunk, or as if his head is swelled.

In the second class of acute cases, in which a man goes into the tunnel immediately after the explosion, and is brought in contact with a large percentage of the poisonous materials, the effects are giddiness, immediately followed by unconsciousness, and the patient presents the usual appearance of asphyxia.

Sometimes in these cases the pulse is full and bounding, though very compressible, but in most of the cases it is alarmingly weak. Generally there is a great pallor, though this may be partially due to working underground. The comatose condition soon passes away, and is succeeded by drowsiness, languor, cold perspiration, intermittent pulse, and generally nausea and vomiting. Sometimes the breathing is spasmodic, and frequently there are hiccough, and after a time a severe headache.

Nearly all of these cases, however, no matter how serious they seem at the time, end in recovery. In the few cases in which death does occur, it is usually several hours after the patient has been removed from the tunnel, and is due to paralysis of respiration.

In the chronic cases, in which only a small amount of the gaseous products of the explosions is breathed daily, there are four prominent symptoms. These are headache, cough, indigestion, and disturbances of the nervous system. The headache is usually a continuing one, and varies in degree from a mere sense of fulness to a throbbing pain. The cough is similar in character to the cough of pertussis, or of malaria, and as cases of malaria are frequent among men engaged upon such works, one may easily mistake the cause.

Next in prominence to these symptoms come disturbances of the nervous system, as trembling, irritability, neuralgia. In fact, nearly, if not all, of the symptoms are attributable to this cause. Even the cough is in all probability due to the poisonous effect produced on the pneumogastric nerve.

With this nervousness is also associated indigestion, probably due to the same cause. Of course, with this latter symptom, the character of the food and the manner in which it was eaten must be taken into consideration; but as soon as a man with these chronic symptoms is taken from the tunnel and placed at work on top he steadily improves, and finally entirely recovers.

It is also noticeable that those who have previously suffered from dyspepsia, or from tic douloureux, or sciatica, or other form of neuralgia, are made worse by the dynamite smoke.

What are these symptoms due to?

The formula for nitroglycerin is $C_3H_5N_3O_9$. And the products from the combustion of this are written:
$4\,(C_3H_5N_3O_9) = 10\,(H_2O) + 12\,(CO) + 6\,(N_2O_2) + O_2$.

In other words, the products are water, carbonic oxide, and nitrogen dioxide, none of which would produce the symptoms above described with the exception of asphyxia.

A comparison of the above symptoms in the acute cases, with the phenomena produced by various-sized doses of nitroglycerin, shows them to be identical. This similarity between the symptoms from inhalation of the products of the explosion of dynamite, and those produced by the nitroglycerin itself, is so well marked that even miners themselves have noticed it. Frequently, when dynamite is frozen, a miner will place a cartridge in his boot to thaw it out, and the absorption of nitroglycerin through the skin will produce precisely the same symptoms as in the mild acute cases of the inhalation of the products before described.

Again, as another instance, I may cite the case of a miner who used his knife to cut a cartridge and afterward ate an apple cut with the same knife. In this case, according to his statement, the symptoms were similar to being "knocked out by powder smoke," only more severe; the headache persisting three weeks. On another occasion this same miner cut up some tobacco to smoke with a knife that he had used for dynamite, and he was again similarly affected. Here the heat from the tobacco smoke volatilized the fine particles of nitroglycerin on the tobacco below, and poisoning was produced by absorption through the lung tissue. No other conclusion can well be reached than this: that there are mixed with the gases produced unexploded particles of nitroglycerin in a volatile state; and these particles inhaled by the miners produce the effect described.

This fact can be conclusively proved by waving in the fumes, immediately after an explosion, a cold sheet of glass, and thus collecting upon it by condensation a small percentage of the nitroglycerin itself.

There is no doubt that the explosion of a large quantity of dynamite would produce sufficient gases of CO and N_2O_2 to produce asphyxia. Here we get the cyanosis and other symptoms of simple asphyxia, and we may get nausea and vomiting; but not the same disturbance of the sympathetic system, nor the continued chronic spasm of the vagus, nor the persistent headache pathognomonic of nitroglycerin poisoning.

Treatment.—In the way of prophylactic treatment the use of such apparatus or machinery, whether by blowing or by sucking, that will rapidly clear the tunnel or cavity from noxious gases or fumes, is to be recommended. When steam drills that are worked with an air compressor are used, they contribute largely to this end. It has also been found that the use of a large cap will explode a greater percentage of nitroglycerin than a small one, and this, to a certain extent, obviates the trouble. In certain cases, however, a cartridge—for some reason or other—does not explode, but burns like a candle, with considerable spluttering. In such an instance the amount of nitroglycerin volatilized is much greater than if an explosion had taken place, and consequently the effects are more deleterious.

For immediate treatment, such measures as are generally used in cases of asphyxia are of service. In addition, the use of cold to the head or the subcutaneous administration of atropine, ergotin, or other vaso-motor stimulant, is of necessity indicated and very efficacious. There is little doubt that the effects of nitroglycerin are produced by its decomposition and the formation of a nitrite in the body. "Treatment with ammonia restores normal color and normal functional power to nitrite-poisoned blood." So the carbonate and aromatic spirits of ammonia should be used internally, and it is also well for those in charge of such works to recommend to the workmen employed to carry with them small vials of this remedy for use in such cases.

The effects of nitroglycerin are also antagonized by sulphur. I have therefore given to many of the workmen sulphide of calcium, and these seemed to do better than those to whom it was not administered. This result, however, may have been partly due to the beneficial effects of the sulphide of calcium *per se.*

III. Manner in which Accidents Occur.—The methods by which accidents occur, and their effect upon the workmen employed, can be best understood if I narrate a few actual occurrences. Thus, the fulminate of mercury will explode violently when compressed. As an illustration of such explosion one of the workmen under my care endeavored to bend a cap so that he might more easily attach it to a dynamite cartridge; and, being ignorant of the conditions under which it would explode, he tried to bend it between his teeth. The result was that he lost half of his teeth, his cheek, and a portion of his ear.

Exploders or caps will also explode when struck a slight blow. Sometimes they are not properly attached to the dynamite cartridge or to the wire connected with the electric battery, and therefore the charge is not exploded. Under these circumstances the cartridge must be removed from the hole and a new cartridge and exploder put in its place. The removal of this cartridge with the exploder in it is attended with great danger. It is done with a long rod, sharp on the point, and with a little cup near the end. Thus with the point the cartridge is broken up, and with the cup it is drawn out of the hole. Should, however, the point of the rod happen to strike the fulminative mercury cap, it is almost sure to explode.

Numerous accidents of this kind occur. One particularly more gross in carelessness or ignorance than the others I will relate.

In firing, in the heading of a tunnel, it frequently becomes necessary to break up the large rocks that are brought down with a blast, so that they can be handled by the workmen. To do this, a single hole is drilled in the centre of the rock and a cartridge placed therein. This is fired when the heading is fired; but sometimes the cartridge becomes loosened and does not go off. On one such occasion a Norwegian seeing one of these holes in a rock that had not been broken up, he placed a bar in the hole and told his companion to hit it to see if there was a cartridge inside. He happened to strike the exploder, and both men were instantly killed, while a third lost his eyesight.

Compression in other ways may explode both the cap and the nitroglycerin; thus, on one occasion when a charge failed to explode, the foreman took a hose attached to the air compressor, and turning it into the hole endeavored to blow it out; the result was that it immediately exploded, his companion was instantly killed, and he himself died later from the injuries received.

Dynamite will not easily explode when frozen, but it can be made to explode even then under some circumstances. As an illustration, the powder man at one of the shafts on the Croton Aqueduct left half a cartridge in a pail of warm water in which he had been thawing it one evening. On the following morning, as it had been a cold night, the water in the pail was frozen with the cartridge at the bottom. Wishing to get the cartridge out of the ice in the pail, he placed it over the blacksmith's fire and blew upon it with the bellows. Both he and the blacksmith were thrown from the building, and from the powder man I removed more than eighty pieces of zinc from the pail.

Under proper conditions in the open air a dynamite cartridge will burn like a candle; but if heated rapidly beyond 306° F. it will explode. Thus, in the Park Avenue tunnel a number of papers, the packing from the boxes, and other inflammable articles were around the powder house. By some means these caught fire and a hot flame was instantly developed about the dynamite, the result being that the whole deflagrated.

A similar accident occurred at Spuyten Duyvil, where some powder, intended for use in making a new road, was stored in a small house. Some children playing in the neighborhood set fire to the grass near the powder house, and the result was an explosion.

In some parts of the country, as in certain mines in the West, where it is not desired to use a large amount of dynamite at any one time, instead of firing with electricity it is customary to use a powder fuse. Where the climate is warm the fuse is often kept with the dynamite, and then it sometimes happens that the nitroglycerin will exude from the cartridges and as a result the fuse which is kept with it will become soaked. Such a fuse will explode instantly, and sometimes even when kept separate from the cartridges they will get covered with machine oil and will then burn more rapidly than is intended. In an accident of this character in Arizona the explosion followed so rapidly the lighting of the fuse that one man could not get away at all, and his assistant had just time to turn his back, from which I later extracted many small pieces of stone.

In the case of nitroglycerin perhaps more accidents occur with the empty can than in any other way. Thus the foreman in a tunnel, who had just filled some holes with nitroglycerin and had emptied the can, set it down in such a manner that the tin in the bottom of the can bent with a slight snap. An explosion immediately followed, and it then became evident that sufficient nitroglycerin had remained in the can, adherent to the sides and the bottom, to drive the major part of the metal into his thigh and hip.

Illustrations of such accidents might be recorded indefinitely, but from many such the following rules have been formulated:

Always remember that the function of an explosive is to explode.

That accidents as a rule are due to carelessness and ignorance.

Workmen who handle nitroglycerin and dynamite should be provided with rubber gloves, to prevent absorption.

Powder for transportation should not be enclosed in a tight or metallic case.

Explosives should be stored at a sufficient distance

from works not to be affected by concussion or by flying débris.

Tools and fuse or caps should be stored or transported separately.

The floor of the powder house should be covered with sawdust and sulphur to absorb and decompose any nitroglycerin that has leaked from a cartridge.

Smoking should not be allowed.

Explosives and powder house should always be marked "dangerous."

Caps must always be examined before attaching them to a cartridge.

In firing by electricity be sure that the wire is disconnected from the battery before attaching the cap or fuse.

Never attempt to remove a charge that will not explode.

Wooden ram rods should be used for charging holes.

Other rules can be formulated from the above article.

Thomas Darlington.

TURMERIC. See *Curcuma.*

TURNIP, WILD or **INDIAN.**—*Arum, Jack-in-the-Pulpit.* The corm of *Arisæma triphyllum* Torr. (American arum) and of *Arum maculatum* L. (European arum). Both these species are very common vernal plants in their respective countries, growing in swamps, along streams, and in other damp and shady places. The American corm is depressed, globose, very much wrinkled, and has a dense circle of curly roots, which arise from the top, around the stem, and descend about the corm. The European is oblong or ovoid, and has the roots at the base. Both usually are found in the market cut into transverse slices, which are white and very starchy. Both are pervaded by an intensely acrid and stinging juice when fresh, but which gradually disappears with drying and keeping, and is dissipated by heat. Small doses of the drug, before this change occurs, act as a very powerful abdominal stimulant, but afterward it is nearly inert. The dose is 0.5–1 gm. (gr. viij.–xv.). It should be given well diluted with mucilage or honey, to mitigate its sharpness. Its use has almost ceased.

Henry H. Rusby.

TURPENTINE.—*American Turpentine* (*Terebinthina,* U. S., P. G.; *Thus Americanum,* Br., *Galipot,* Cod. Med.). A concrete oleoresin obtained from *Pinus palustris* Miller, and from other species of *Pinus* (fam. *Pinaceæ* or *Coniferæ*). The species of pine here referred to form large forests in the Altantic and gulf belts of the Southeastern United States, where the turpentine is collected on an enormous scale. By the carelessness of the Government in permitting the present ruinous methods of collection, the destruction of the sources of this article is a question of a very short time only.

Deep gashes are cut in the trunks of the trees, near the ground, and hollowed out at the bottom so as to hold a pint or more of liquid, and, above these, slight cuts are made in the bark, from which the turpentine flows, and, running down, is collected in the "boxes," as the excavated gashes are called; from these it is ladled out from time to time as the boxes fill, and fresh hacks are occasionally made in the bark above to keep up the flow. The freshly collected turpentine is then filled into barrels and carried to the still, where the oil is distilled off, being the spirit of turpentine, as it is commonly called, of commerce.

Turpentine is described as occurring in yellowish, opaque, tough masses, brittle in the cold, crumbly-crystalline in the interior, of a terebinthinate odor and taste. The alcoholic solution has an acid reaction.

As indicated in its definition, turpentine consists of oil of turpentine and resin. A small amount of bitter substance is also present. Its properties, medicinally, are wholly those of the oil, considered below, which is present to the extent of from fifteen to thirty per cent., weakened by the resin, also considered below. The uses of all three of the articles, as well as their preparations, are considered together at the close of this article:

Oil of Turpentine (*Oleum Terebinthinæ,* U. S.; Br., *Spirit of Turpentine*) is defined as a volatile oil distilled from turpentine, and is thus described:

A thin, colorless liquid, having a characteristic odor and taste, both of which become stronger and less pleasant by age and exposure to the air.

Specific gravity: 0.855 to 0.870 at 15° C. (59° F.).

It boils at 155° to 170° C. (311° to 338° F.).

Soluble in three times its volume of alcohol, the solution being neutral or slightly acid to litmus paper; also soluble in an equal volume of glacial acetic acid.

Bromine or powdered iodine acts violently upon it.

When brought in contact with a mixture of nitric and sulphuric acids, it takes fire.

If a little of the oil be evaporated in a small capsule on a water bath, it should leave no more than a very slight residue (absence of *petroleum, paraffin oils,* or *resin*).

There is a rectified form of it (*Oleum Terebinthinæ Rectificatum,* U. S., P. G.) made by shaking up the crude oil with six times its amount of lime water and redistilling, which is thus described:

A thin, colorless liquid, having the general properties mentioned under oil of turpentine (see *Oleum Terebinthinæ,* above).

Specific gravity: 0.855 to 0.865 at 15° C. (59° F.).

Boiling point: about 160° C. (320° F.).

Its alcoholic solution should be neutral to litmus paper.

If about 10 c.c. of the oil be evaporated in a capsule on a water bath, no weighable residue should be left.

Upon treatment of oil of turpentine with hydrochloric acid, and some similarly acting substances, a kind of camphor, closely resembling ordinary camphor, can be produced.

Rosin (*Resina,* U. S., Br.; *Colophonium,* P. G., *Colophony, Common Resin,* or *Rosin*) is defined as the residue left after distilling off the volatile oil from turpentine, and is described as a transparent, amber-colored substance, hard, brittle, pulverizable; fracture glossy and shallowly conchoidal; odor and taste faintly terebinthinate. Specific gravity 1.070–1.080. Soluble in alcohol, ether, and fixed or volatile oils; also in solution of potassium or sodium hydrate. Rosin varies considerably in its appearance, according to the extent of its distillation. If the water with which it was distilled has not been entirely boiled out, it is opaque and yellow; if it contains no water, it is clear; if overheated, it is dark brown or black, if not, it is bright and clear. The abietic acid in the opaque "thus" is a product of hydration of rosin, and may be produced in ordinary rosin by treating with diluted alcohol.

Action and Uses.—Oil of turpentine is one of the most irritating of its series. Applied to the skin and prevented from evaporating, it quickly causes smarting and redness, and after a quarter of an hour or more is liable to destroy the surface and cause ulceration. In large doses, 10 or 15 gm., taken internally, it is a quick irritant, causing prompt action, but is unsafe. Used with suds or other vehicle, as a rectal injection, it is promptly rejected, and in consequence is a useful stimulating evacuant of the lower bowel. Oil of turpentine is readily absorbed in vapor by the lungs, as well as in its liquid condition by the stomach. It is excreted also by the lungs as well as by the skin and kidneys, the latter principally in the course of its elimination; it is, if in large quantity, an irritant to the whole urinary system, causing strangury, frequent micturition, hæmaturia, etc. The urine has a rather pleasant violet-like odor. Like all essential oils it is an antiseptic. In small doses (a few drops) it is stimulant and hæmostatic, and is frequently given with good effect in the hemorrhage of typhoid and phthisis. In large amounts, 2 or 3 gm. and upward, there are mental exhilaration, intoxication; and in poisonous doses dulness, coma, and convulsions, with muscular weakness and heart failure.

The oil is frequently employed as an irritant application (turpentine stupe); a flannel pad wrung out from